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A
SYNOPSIS
OF THE
ASTRONOMY
OF
COMETS.

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MEMORANDUM

COMMITTEE

BY THE BOARD OF DIRECTORS
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REPORT OF THE COMMITTEE
ON THE DEAF AND DUMB

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A
SYNOPSIS
OF THE
Astronomy of Comets.

THE ancient *Egyptians* and *Chaldeans* (if we may credit *Diodorus Siculus*) by a long Course of Observations, were able to predict the *Apparitions* of Comets. But since they are also said, by the Help of the same Arts, to have prognosticated Earthquakes and Tempests, 'tis past all Doubt, that their Knowledge in these Matters, was the Result rather of meer *Astrological Calculation*, than of any *Astronomical Theories* of the *Cœlestial Motions*. And the *Greeks*, who were the Conquerors of both those People, scarce found any other sort of Learning amongst them, than this. So that 'tis to the *Greeks* themselves as the Inventors (and especially to the Great *Hipparchus*) that we owe this *Astronomy*, which is now improv'd to such a Height. But yet, amongst these, the Opinion of *Aristotle* (who wou'd have Comets to be nothing else, but Sublunary Vapours, or Airy Meteors)

prevail'd so far, that this most difficult Part of the Astronomical Science lay altogether neglected; for no Body thought it worth while to take Notice of, or write about, the Wandring uncertain Motions of what they esteemed Vapours floating in the *Aether*; whence it came to pass, that nothing certain, concerning the Motion of Comets, can be found transmitted from them to us.

But *Seneca* the *Philosopher*, having consider'd the *Phænomena* of Two remarkable Comets of his Time, made no Scruple to place them amongst the *Cælestial* Bodies; believing them to be *Stars* of equal Duration with the World, tho' he owns their Motions to be govern'd by Laws not as then known or found out. And at last (which was no untrue or vain Prediction) he foretells, that there should be Ages sometime hereafter, to whom Time and Diligence shou'd unfold all these Mysteries, and who shou'd wonder that the Ancients cou'd be ignorant of them, after some lucky Interpreter of Nature had shewn; *in what Parts of the Heavens the Comets wander'd, what, and how great they were.* Yet almost all the Astronomers differ'd from this Opinion of *Seneca*; neither did *Seneca* himself think fit to set down those *Phænomena* of the Motion, by which he was enabled to maintain his Opinion: Nor the *Times* of those Appearances, which might be of use to Posterity, in order to the Determining these Things. And indeed, upon the Turning over very many Histories of Comets, I find nothing at all that can be of Service in this Affair, before, *A. D.* 1337. at which time *Nicephorus Gregoras*, a *Constantinopolitan Historian* and *Astronomer*, did pretty

pretty accurately describe the *Path* of a Comet amongst the Fix'd Stars, but was too laxe as to the Account of the *Time* ; so that this most doubtful and uncertain Comet, only deserves to be inserted in our Catalogue, for the sake of its appearing near 400 Years ago.

Then the next of our Comets was in the Year 1472, which being the swiftest of all, and nearest to the Earth, was observ'd by *Regiomontanus*. This Comet (so frightful upon the Account both of the Magnitude of its Body, and the Tail) mov'd Forty Degrees of a great Circle in the Heavens, in the Space of one Day ; and was the first, of which any proper Observations are come down to us. But all those that consider'd Comets, until the Time of *Ticho Brahe* (that great Restorer of Astronomy) believ'd them to be below the Moon, and so took but little Notice of them, reckoning them no other than Vapours.

But in the Year 1577, (*Ticho* seriously pursuing the Study of the Stars, and having gotten large Instruments for the Performing Cœlestial Mensurations, with far greater Care and Certainty, than the Ancients cou'd ever hope for) there appear'd a very remarkable Comet ; to the Observation of which, *Ticho* vigorously applied himself ; and found by many just and faithful Trials, that it had not a *Diurnal Parallax* that was at all perceptible : And consequently was not only no Aïreal Vapour, but also much higher than the Moon ; nay, might be plac'd amongst the Planets for any thing that appear'd to the Contrary ; the cavilling Opposition made by some of the

School-men in the mean time, being to no Purpose.

Next to *Ticho*, came the Sagacious *Kepler*. He having the Advantage of *Ticho's* Labours and Observations, found out the true *Physical* System of the World, and vastly improv'd the *Astronomical* Science.

For he demonstrated that all the Planets perform their Revolutions in *Elliptick Orbits*, whose Plains pass thro' the Center of the Sun, observing this Law, That the Area's (of the *Elliptick Sectors*, taken at the Center of the Sun, which he proved to be in the common Focus of these *Ellipses*) are always proportional to the Times, in which the correspondent *Elliptical Arches* are describ'd. He discover'd also, That the Distances of the Planets from the Sun are in the *Sesquialtera Ratio* of the Periodical Times, or (which is all one) That the Cubes of the Distances are as the Squares of the Times. This great Astronomer had the Opportunity of observing Two Comets, one of which was a very remarkable one. And from the Observations of these (which afforded sufficient Indications of an *Annual Parallax*) he concluded, That the Comets mov'd freely thro' the Planetary Orbs, with a Motion not much different from a *Rectilinear* one; but of what Kind he cou'd not then precisely determine. Next, *Hewelius* (a Noble Emulator of *Ticho Brahe*) following in *Kepler's* Steps, embraced the same Hypothesis of the *Rectilinear Motion* of Comets, himself accurately observing many of them. Yet, he complain'd, that his Calculations did not perfectly agree to the Matter of Fact in the Heavens: And was aware, that the Path of a Comet was bent into a Curve Line towards the

Sun.

Sun. At length, came that prodigious Comet of the Year 1680. which descending (as it were) from an infinite Distance *Perpendicularly* towards the Sun, arose from him again with as great a Velocity.

This Comet, (which was seen for Four Months continually) by the very remarkable and peculiar Curvity of its Orbit (above all others) gave the fittest Occasion for investigating the *Theory of the Motion*. And the *Royal Observatories* at *Paris* and *Greenwich* having been for some time founded, and committed to the Care of most excellent *Astronomers*, the apparent Motion of this Comet was most accurately (perhaps as far as Humane Skill cou'd go) observ'd by *Mrs. Cassini* and *Flamsteed*.

Not long after, that *Great Geometrician*, the *Illustrious Newton*, writing his *Mathematical Principles of Natural Philosophy*, demonstrated not only that what *Kepler* had found, did necessarily obtain in the *Planetary System*; but also, that all the *Phænomena* of Comets wou'd naturally follow from the same Principles; which he abundantly illustrated by the Example of the aforesaid Comet of the Year 1680. shewing, at the same time, a Method of Delineating the Orbits of Comets Geometrically; wherein he (not without the highest Admirati-on of all Men) solv'd a Problem, whose Intricacy render'd it worthy of himself. This Comet he prov'd to move round the Sun in a Parabolical Orb, and to describe Area's (taken at the Center of the Sun) proportional to the Times.

Where-

Wherefore (following the Steps of so Great a Man) I have attempted to bring the same Method to *Arithmetical Calculation*; and that with desired Success. For, having collected all the Observations of Comets I could, I fram'd this Table, the Result of a prodigious deal of Calculation, which, tho' but small in Bulk, will be no unacceptable Present to Astronomers. For these Numbers are capable of Representing all that has been yet observ'd about the Motion of Comets, by the Help only of the following *General Table*; in the making of which I spar'd no Labour, that it might come forth perfect, as a Thing consecrated to Posterity, and to last as long as *Astronomy* it self.

The

*The Astronomical Elements of the Motions in a Parabolick Orb
of all the Comets that have been hitherto duly observ'd.*

Comet. An.	Nodes Ascend.	Inclin. Orbitæ.	Perihelion.	Distan. Perihelia à Sol.	Log. Dist. Perihelia à Sole.	Temp equat. Perihelii.	Perihelion à Node.
	gr. ' "	gr. ' "	gr. ' "			d. h. ' "	gr. ' "
1337	♂ 24.21.0	32.11.0	♂ 7.59.0	40666	9.609236	June 2. 6.25	46.22.0 Retrog.
1472	♂ 11.46.20	5.20.0	♂ 15.33.30	54273	9.734584	Feb. 28.22.23	123.47.10 Retrog.
1531	♂ 19.25.0	17.56.0	♂ 1.39.0	56700	9.753583	Aug. 24.21.18½	107.46.0 Retrog.
1532	♂ 20.27.0	32.36.0	♂ 21.7.0	50910	9.706803	Oct. 19.22.12	30.40.0 Direct.
1556	♂ 25.42.0	32.6.30	♂ 8.50.0	46390	9.666424	Apr. 21.20.3	103.8.0 Direct.
1577	♂ 25.52.0	74.32.45	♂ 9.22.0	18342	9.263447	Oct. 26.18.45	103.30.0 Retrog.
1580	♂ 18.57.20	54.40.0	♂ 19.5.50	59628	9.775450	Nov 28 15.00	90.8.30 Direct.
1585	♂ 7.42.30	6.4.0	♂ 8.51.0	109358	0.038880	Sept. 27.19.20	28.51.30 Direct.
1590	♂ 15.30.40	29.40.40	♂ 6.54.30	57661	9.760882	Jan. 29. 3.45	51.23.50 Retrog.
1596	♂ 12.12.30	55.12.0	♂ 18.16.0	51293	9.710058	July 31.19.55	83.56.30 Retrog.
1607	♂ 20.21.0	17.2.0	♂ 2.16.0	58680	9.768490	Oct. 16. 3.50	108.05.0 Retrog.
1618	♂ 16. 1.0	37.34.0	♂ 2.14.0	37975	9.579498	Oct. 29.12.23	73.47.0 Direct.
165.	♂ 28.10.0	79.28.0	♂ 28.18.40	84750	9.928140	Nov. 2.15.40	59.51.20 Direct.
1661	♂ 22.30.30	32.35.50	♂ 25.58.40	44851	9.651772	Jan. 16.23.41	33.28.10 Direct.
1664	♂ 21.14.0	21.18.30	♂ 10.41.25	102575½	9.011044	Nov 24.11.52	49.27.25 Retrog.
1665	♂ 18.02.0	76.05.0	♂ 11.54.30	10649	9.027309	Apr. 14. 5.15½	156.7.30 Retrog.
1672	♂ 27.30.30	83.22.10	♂ 16.59.30	69739	9.843476	Feb. 20. 8.37	109.29.0 Direct.
1677	♂ 26.49.10	79.03.15	♂ 17.37. 5	28059	9.448072	Apr. 26.00.37½	99.12. 5 Retrog.
1680	♂ 2. 2. 0	50.56.0	♂ 22.39.30	00612½	7.787106	Dec. 8.00. 6	9.22.30 Direct.
1682	♂ 21.15.30	17.56.0	♂ 2.52.45	58328	9.765877	Sept. 4.07.39	108.23.45 Retrog.
1683	♂ 23.23.0	33.11.0	♂ 25.29.30	56020	9.748343	July 3. 2.50	87.53.30 Retrog.
1684	♂ 28.15.0	55.48.40	♂ 28.52.0	96015	9.982339	May 29.10.16	29.23.00 Direct.
1686	♂ 20.34.40	31.21.40	♂ 17.00.30	32500	9.511883	Sept. 6.14.33	86.25.50 Direct.
1698	♂ 27.44.10	11.46.0	♂ 00.51.15	69129	9.839660	Oct. 8.16.57	2.7.0 Retrog.

This Table needs little Explication, since 'tis plain enough from the Titles, what the Numbers mean. Only it may be observ'd, that the *Perihelium* Distances, are estimated in such Parts, as the Middle Distance of the Earth from the Sun, contains 100000.

*A General Table for Calculating the
Motions of Comets in a Parabolical
Orbit.*

Med. mot.	Ang. a perihelio.	Logar. pro dist. à Sole.	Med. mot.	Ang. a perihelio.	Logar. pro dist. à Sole.
0	gr. ' "		0	gr. ' "	
1	1.31.40	0.000077	31	42.55.06	0.062400
2	3. 3.15	0.000309	32	44. 3.20	0.065838
3	4.34.43	0.000694	33	45.10.29	0.069319
4	6. 6. 0	0.001231	34	46.16.35	0.072839
5	7.37. 1	0.001921	35	47.21.36	0.076396
6	9. 7.43	0.002759	36	48.25.33	0.079984
7	10.38. 2	0.003745	37	49.28.27	0.083600
8	12. 7.54	0.004876	38	50.30.19	0.087244
9	13.37.17	0.006151	39	51.31. 8	0.090910
10	15. 6. 7	0.007564	40	52.30.56	0.094596
11	16.34.20	0.009115	41	53.29.44	0.098300
12	18. 1.54	0.010798	42	54.27.32	0.102019
13	19.28.47	0.012609	43	55.24.21	0.105752
14	20.54.54	0.014550	44	56.20.12	0.109490
15	22.20.14	0.016607	45	57.15. 6	0.113240
16	23.44.44	0.018783	46	58. 9. 3	0.116995
17	25. 8.22	0.021072	47	59. 2. 4	0.120756
18	26.31. 8	0.023470	48	59.54.11	0.124518
19	27.52.55	0.025969	49	60.45.25	0.128278
20	29.13.47	0.028570	50	61.35.45	0.132035
21	30.33.40	0.031263	51	62.25.14	0.135792
22	31.52.32	0.034045	52	63.13.52	0.139544
23	33.10.23	0.036916	53	64. 1.40	0.143291
24	34.27.12	0.039864	54	64.48.38	0.147029
25	35.42.59	0.042892	55	65.34.50	0.150762
26	36.57.41	0.045989	56	66.20.13	0.154482
27	38.11.20	0.049154	57	67.04.50	0.158192
28	39.23.54	0.052382	58	67.48.42	0.161890
29	40.35.23	0.055668	59	68.31.50	0.165578
30	41.45.47	0.059009	60	69.14.16	0.169254

Med. mor.	Angul. à perihelio.	Logar. pro dist. à Sole.	Med. mor.	Ang. à perihelio.	Logar. pro dist. à Sole.
o	gr. ' "		o	gr. ' "	
61	69.55.58	0.172914	91	86.20.34	0.271176
62	70.36.56	0.176557	92	86.46.20	0.277239
63	71.17.16	0.180188	93	87.11.43	0.280284
64	71.56.56	0.183803	94	87.36.45	0.283306
65	72.35.57	0.187404	95	88.01.27	0.286308
66	73.14.15	0.190978	96	88.25.49	0.289293
67	73.51.59	0.194540	97	88.49.48	0.292252
68	74.29.6	0.198085	98	89.13.32	0.295201
69	75.05.38	0.201614	99	89.36.54	0.298122
70	75.41.35	0.205122	100	90.00.00	0.301030
71	76.16.56	0.208612	102	90.45.14	0.306782
72	76.51.43	0.212080	104	91.29.18	0.312469
73	77.25.57	0.215529	106	92.12.14	0.318060
74	77.59.41	0.218963	108	92.54.4	0.323587
75	78.32.54	0.222378	110	93.34.52	0.329042
76	79.5.35	0.225769	112	94.14.40	0.334424
77	79.37.45	0.229142	114	94.53.30	0.339736
78	80.9.23	0.232488	116	95.31.22	0.344979
79	80.40.34	0.235809	118	96.8.22	0.350153
80	81.11.16	0.239127	120	96.44.30	0.355262
81	81.41.31	0.242416	122	97.19.48	0.360306
82	82.11.19	0.245684	124	97.54.17	0.365284
83	82.40.40	0.248933	126	98.28.00	0.370200
84	83.9.34	0.252159	128	99.00.57	0.375052
85	83.38.4	0.255366	130	99.33.11	0.379842
86	84.6.8	0.258552	132	100.4.43	0.384576
87	84.33.49	0.261720	134	100.35.45	0.389252
88	85.1.5	0.264865	136	101.5.48	0.393868
89	85.27.58	0.267989	138	101.35.22	0.398428
90	85.54.27	0.271092	140	102.4.19	0.402920

Med. mot.	Ang. à perihelio.	Logar. pro. dist. à Sole.	Med. mot.	Ang. à perihelio	Logar. pro dist. à Sole.
o	gr. ' "		o	gr. ' "	
142	102.32.41	0.407380	204	113.37.25	0.523406
144	103.00.31	0.411784	208	114. 9.52	0.529705
146	103.27.47	0.416132	212	114.41.23	0.535886
148	103.54.31	0.420430	216	115.12.02	0.541958
150	104.20.43	0.424676	220	115.41.51	0.547922
152	104.46.22	0.428866	224	116.10.52	0.553782
154	105.11.33	0.433012	228	116.39. 7	0.559538
156	105.36.16	0.437110	232	117. 6.38	0.565199
158	106.00.32	0.441164	236	117.33.27	0.570762
160	106.24.23	0.445178	240	117.59.38	0.576233
162	106.47.47	0.449144	244	118.25. 5	0.581616
164	107.10.44	0.453060	248	118.49.57	0.586912
166	107.33.17	0.456936	252	119.14.14	0.592122
168	107.55.27	0.460772	256	119.37.56	0.597252
170	108.17.14	0.464208	260	120. 1. 6	0.602301
172	108.38.37	0.468318	264	120.23.44	0.607274
174	108.59.39	0.472030	268	120.45.52	0.612174
176	109.20.20	0.475705	272	121. 7.30	0.616998
178	109.40.40	0.479340	276	121.28.39	0.621750
180	110.00.40	0.482937	280	121.49.22	0.626438
182	110.20.20	0.486498	284	122. 9.38	0.631056
184	110.39.41	0.490022	288	122.29.28	0.635608
186	110.58.44	0.493512	292	122.48.54	0.640098
188	111.17.28	0.496965	296	123. 7.57	0.644525
190	111.35.55	0.500384	300	123.26.36	0.648893
192	111.54.05	0.503769	310	124.11.40	0.659559
194	112.11.58	0.507121	320	124.54.36	0.669880
196	112.29.34	0.510441	330	125.35.34	0.679876
198	112.46.55	0.513729	340	126.14.44	0.689568
200	113. 4.00	0.516984	350	126.52.12	0.698970

Med. mot.	Ang. à peribelio.	Logar. pro dist. à Sole.	Med. mot.	Ang. à peribelio	Logar. pro dist. à Sole.
o	gr. ' "		o	gr. ' "	
360	127.28. 6	0.708104	820	141.49.24	0.970836
370	128. 2.33	0.716976	840	142.10.00	0.978397
380	128.35.38	0.725606	860	142.29.56	0.985771
390	129. 7.27	0.734006	880	142.49.10	0.992970
400	129.38. 4	0.742186	900	143. 7.48	0.100000
410	130. 7.34	0.750160	920	143.25.51	1.006871
420	130.36. 2	0.757930	940	143.43.21	1.013586
430	131. 3.30	0.765516	960	144.00.18	1.020155
440	131.30. 2	0.772918	980	144.16.46	1.026583
450	131.55.41	0.780148	1000	144.32.46	1.032876
460	132.20.30	0.787216	1500	149.26. 8	1.158188
470	132.44.32	0.794122	2000	152.26.15	1.246058
480	133. 7.50	0.800882	2500	154.32.20	1.313703
490	133.30.25	0.807494	3000	156. 7.27	1.368678
500	133.52.20	0.813969	3500	157.22.49	1.414974
520	134.34.18	0.826522	4000	158.24.36	1.454950
540	135.14. 0	0.838600	4500	159.16.36	1.490125
560	135.51.28	0.850187	5000	160. 1.12	1.521521
580	136.27. 6	0.861369	5500	160.40. 5	1.549874
600	137.00.57	0.872155	6000	161.14.24	1.575718
620	137.33.13	0.882575	6500	161.45.00	1.599460
640	138. 3.58	0.892649	7000	162.12.34	1.621417
660	138.33.21	0.902401	7500	162.37.34	1.641838
680	139. 1.29	0.911866	8000	163.00.23	1.660922
700	139.28.25	0.921012	8500	163.21.20	1.678834
720	139.54.16	0.929907	9000	163.40.42	1.695708
740	140.19. 5	0.938549	9500	163.58.38	1.711662
760	140.42.56	0.946951	10000	164.15.20	1.726784
780	141.05.55	0.955124	50000	170.52. 0	2.197960
800	141.28. 3	0.963082	100000	172.45.44	2.399655

*The Construction and Use of the
general Table.*

As the Planets move in *Elliptick Orbs*, so do the Comets in *Parabolick* ones, having the Sun in their common *Focus*, and describe equal *Area's* in equal *Times*. But now because all *Parabola's* are *similar* to one another, therefore if any determinate Part of the *Area* of a given *Parabola*, be divided into any Number of Parts at Liberty, there will be a *like* Division made in all *Parabola's*, under the same Angles, and the Distances will be proportional: And consequently this one Table of ours will serve for all Comets. Now, the Manner of the Calculation of this Table is thus: In the *Fig.*

Let S be the *Sun*, POC the Orbit of a Comet, P the *Perihelion*, O the Place where the Comet is 90 gr. distant from the Sun, C any other Place. Draw the Right Lines CP, CS, and make ST, SR, equal to CS; and then having drawn the Right Lines CR, CT, (whereof the one is a Tangent, and the other a Perpendicular to the Curve) let fall CQ perpendicular to the *Axis* PSR,

Now,

Now, any *Area*, as COPS, being given, 'tis requir'd to find the Angle CSP, and the Distance CS. From the Nature of the *Parabola* RQ is ever $= \frac{1}{2}$ the Parameter of the *Axis*, and consequently if the Parameter be put $= 2$, then RQ $= 1$. Let CQ $= z$; then PQ shall $= \frac{1}{2} z z$, and the Parabolick Segment COP $= \frac{1}{12} z z z$. But the Triangle CSP will $= \frac{1}{4} z$, and so the Mixtilineal *Area* COPS $= \frac{1}{12} z^3 + \frac{1}{4} z = a$, whence $z^3 + 3z = 12a$. Wherefore resolving this Cubical Equation, z or the Ordinate CQ will be known. Now, let the *Area* OPS be propos'd to be divided into 100 Parts; this *Area* is $\frac{1}{12}$ of the Square of the Parameter, and consequently $12a$ is $=$ that Square $= 4$. If therefore the Roots of these Equations $z^3 + 3z = 0,04 : 0,08 : 0,12 : 0,16$, &c. be successively extracted, there will be obtain'd so many z or Ordinates CQ respectively, and the *Area* SOP will be divided into 100 Parts. And in like manner is the *Calculus* to be continued beyond the Place O. Now the Root of this Equation (since RQ is $= 1$) is the Tabular Tangent of the Angle CRQ, or $\frac{1}{2}$ the Angle CSP, and so the Angle CSP is given. And RC, the Secant of the same Angle CRQ, is a mean Proportional between RQ or Unity, and RT, which is the Double of SC, as is plain from the *Conicks*. But if SP be put $= 1$, and so the *Latus Rectum* $= 4$ (as in our Table) then RT will be the Distance sought, viz. the Double of SC in the former *Parabola*. After this manner therefore, I compos'd the foregoing Table, which serves to represent the Motions of all Comets: For hitherto there has been none observ'd, but comes within the Laws of the *Parabola*.

It

It remains now, that we give the Rules for the Calculation, and shew the Way of determining the Place of a Comet seen, by these Numbers. *The Velocity of a Comet moving in a Parabola, is every where to the Velocity of a Planet describing a Circle about the Sun, at the same Distance from the Sun, as $\sqrt{2}$ to 1.* as appears from Cor. 7. Prop. 16. Lib. 1. of the Princip. Phil. Nat. Math. If therefore a Comet in its *Perihelium* were suppos'd to be as far distant from the Sun as the Earth is, then the Diurnal *Area* which the Comet wou'd describe, wou'd be to the Diurnal *Area* of the Earth, as $\sqrt{2}$ to 1. And consequently, the Time of the Annual Revolution, is to the Time in which such a Comet wou'd describe a Quadrant of its Orbit from the *Perihelium*, as 3.14159, &c. (that is the *Area* of the Circle) to $\sqrt[8]{9}$. Therefore the Comet wou'd describe that Quadrant in 109 Days, 14 Hours, 46 Minutes; and so that Parabolick *Area* (Analogous to the *Area POS*) being divided into 100 Parts, to each Day there wou'd be allotted 0.912280. of those Parts; the Log. of which, viz. 9.960128, is to be kept for continual Use. But then the Times in which a Comet, at a greater or less Distance, wou'd describe similar Quadrants, are as the Times of the Revolutions in Circles, that is, in the Sefquiplicate Ratio of the Distances: And so the Diurnal *Area's*, estimated in Centesimal Parts of the Quadrant (which Parts we put for Measures of the mean Motion, like Degrees) are in each, in the Subsesquialtera Proportion of the Distance from the Sun in the Perihelion.

These

These necessary Things premis'd, let it be propos'd to compute the *apparent Place* of any one of the mention'd Comets, for any *Given Time*. Therefore,

1. Let the Sun's Place be had, and the Log. of its Distance from the Earth.

2. Let the Difference between the Time of the Perihelion, and the Time given, be gotten, in Days and Decimal Parts of Days. To the Log. of this Number, let there be added the constant Log. 9.960128, and the Complement Arithmetical of the $\frac{2}{3}$ of the Log. of the Distance in the Perihelium from the Sun: The Sum will be the Log. of the Mean Motion, to be sought in the first Column of the General Table.

3. With the Mean Motion let there be taken the correspondent Angle from the Perihelium, in the Table, and the Log. for the Distance from the Sun: Then in Comets that are Direct, add, and in Retrograde ones subtract; if the Time be after the Perihelium, the Angle thus found, to or from the Place of the Perihelion; or in Direct Comets, subtract; and in Retrograde ones, add; if the Time be before the Perihelion, the foresaid Angle to or from the Place of the Perihelion; and so we shall have the Place of the Comet in its Orbit. And to the Log. found for the Distance, let there be added the Log. of the Distance in the Perihelion, and the Sum will be the Log. of the true Distance of the Comet from the Sun.

4. The Place of the Node, together with the Place of the Comet in its Orbit, being given, let the Distance of the Comet from the Node be found; then, the Inclination of the Plane being given, there will be given also (from the common Rules of Trigonometry) the Comet's Place reduced to the Ecliptick, the Inclination or Heliocentrick Latitude, and the Log. of the curtate Distance.

5. From

5. From these Things given (by the very same Rules that we find the Planets Places, from the Sun's Place and Distance given) we may obtain the Apparent or Geocentrick Place of the Comet, together with the Apparent Latitude. And this it may be worth while to illustrate by an Example or two.

EXAMPLE I.

Let it be requir'd to find the Place of the Comet of the Year 166⁴₅, March 1^d, 7^h, 00', P. M. London. That is. 96^d, 19^h, 8', after the Perihelion, which happen'd Novemb. 24^o, 11^h, 52'.

Log. Dist. Perihel.	0. 011044
Log. Sesquialt.	0. 016566
Comp. Arith.	9 983434
	9. 960128
Log. Temp.	1. 985862
Log. Med. Mot.	1. 929424
Medius Motus	85.001

Perihel. Ω	10. 41. 25
Ang. Corresp.	83. 38. 05—
Comet. in Orb. γ	17. 3. 20
Ascend. Nod. II	21. 14. 00
Com. à Nodo	34. 10. 40
Red. ad Eclip.	32 19. 05
Com. Helioc. γ	18. 54. 55
Incl. Bor.	11. 46. 50

Log. pro dist.	0. 255369
Log. Perihel.	0. 011044
Co-fin. Incl.	9. 990754
Log. dist. Curt.	0. 257167
Log. dist. $\odot$	9. 997918
$\odot$ $\times$	21. 44. 45
Com. Visus γ	29. 18. 30
Lat. Vifa	8. 36. 15

EXAMPLE

EXAMPLE II.

Let it be requir'd to find the Place of the Comet of the Year 1683, July 23^o, 13^h, 35', P.M. London: Or, 13^h, 40' Equat. Time. That is, 21^d, 10^h, 50' after the Perihelion.

Log. dist. Perihel.	9. 748343
Log. Sefquialt.	9. 622514
Comp. Arith.	0. 377486
	9. 960128
Log. Temp.	1. 310723
Log. Med. Mot.	1. 648337
Medius Motus	44. 498

Perihel. II	25. 29. 30
Ang. Corresp.	56. 47. 20
Comet. in Orb. γ	28. 42. 10
Nod. Descend. $\propto$	23. 23. 00
Com. à Nodo	35. 19. 10
Red. ad Eclip.	4. 48. 30
Com. Helioc. $\propto$	28. 11. 30
Incl. Bor.	35. 2. 00

Log. pro dist.	0. 111336
Log. Perihel.	9. 748343
Co-fin. Incl.	9. 913187
Log. dist Curt.	9. 772866
Log. dist. $\odot$.	0. 006104
$\odot$ Locus Ω	10. 41. 25
Com. Vifus ∞	5. 11. 50
Lat. Bor.	28. 52. 00

At the Instant of Time specified in the first Example, 'twas observ'd (at London) that the Comet applied to the Second Star of *Aries*; so that it was found to be 9' more Northerly,

C

and

and 3' to the East, according to Mr. *Hook's* Observation. But at that of the Second Example, I my self (near *London*, with the same Instruments whereby I formerly observ'd the Southern Constellations) found the Place of the Comet to be $28^{\circ}, 52'$ North Latitude, which agreed exactly with the Observation made at *Greenwich* almost the very same Moment.

As for the Comet of the Year 1680, which came almost to the very *Sun* it self (being in its *Perihelion*, not above $\frac{1}{3}$ of the *Semi-Diameter* of the *Sun* distant from the Surface of it) since the *Latus Rectum* is so very small, could hardly be contained within the Limits of the General Table, because of the excessive Velocity of the *Mean Motion*. Therefore in this Comet, the best Way is (after the *Mean Motion* is found) to get from thence (by the Help of the foregoing Equation $z^3 + 3z = \frac{4}{100}$ of the *Mean Motion*) the Tangent of Half the Angle from the *Perihelion*, together with the Log. for the Distance from the *Sun*. Which Things being given, we are to proceed by the same Rules, as in the rest.

After this Manner therefore, the Astronomical Reader may examine these Numbers, which I have calculated, with all imaginable Care, from the Observations I have met with. And I have not thought fit to make them publick before they have been duly examin'd, and made as accurate as 'twas possible, by the Study of many Years. I have publish'd this Specimen of Cometical Astronomy, as a *Prodromus* of a designed future Work, lest, happening to

to die, these Papers might be lost, which every Man is not capable to retrieve, by reason of the great Difficulty of the Calculation. Now, it may not be amiss to put the Reader in mind, That our Five first Comets, (the Third and Fourth observ'd by *Peter Apian*, the Fifth by *Paulus Fabricius*) as also the Tenth seen by *Mastlin*, if I mistake not, in the Year 1596. are not so certain as the rest; for the Observations were made neither with fit Instruments, nor due Care, and upon that Account are disagreeing with themselves, and can by no means be reconcil'd with a regular Computation. The Comet which appear'd in the Year 1684. was only taken Notice of by *Blanchinus*, who observed at *Rome*: And the last, which appear'd in the Year 1698. was seen only by those at *Paris*, who determin'd its Course in a very uncommon Way. This Comet was very obscure; and, altho' it mov'd swift, and came near enough our Earth; yet we, who are wont to be curious enough in these Matters, saw nothing of it. For want of Observations I have left out of the foregoing Catalogue, those Two remarkable Comets which have appear'd in this our Age, one in *November*, in the Year 1689. the other in *February* in the Year 1702. For they directing their Course towards the Southern Parts of the World, and being scarce conspicuous here in *Europe*, met with no Observers capable of the Business. But, if any one shall bring from *India*, or the Southern Parts, an accurate Series of requisite Observations, I will willingly fall to work again, and undergo the Fatigue of representing their Orbits in Numbers, as I have done the rest.

By comparing together the Accounts of the Motions of these Comets, 'tis apparent, their Orbits are dispos'd in no manner of Order; nor can they, as the Planets are, be comprehended within a *Zodiack*, but move indifferently every Way, as well Retrograde as Direct; from whence it is clear, they are not carry'd about or mov'd in *Vortices*. Moreover, the Distances in their *Perihelium's* are sometimes greater, sometimes less; which makes me suspect, there may be a far greater Number of them, which moving in Regions more remote from the Sun, become very obscure; and wanting Tails, pass by us unseen:

Hitherto I have consider'd the Orbits of Comets as exactly *Parabolick*; upon which Supposition it wou'd follow, that Comets being impell'd towards the Sun by a Centripetal Force, descend as from Spaces infinitely distant, and by their Falls acquire such a Velocity, as that they may again run off into the remotest Parts of the Universe, moving upwards with such a perpetual Tendency, as never to return again to the Sun. But since they appear frequently enough, and since none of them can be found to move with an Hyperbolick Motion, or a Motion swifter than what the a Comet might acquire by its Gravity to the Sun, 'tis highly probable they rather move in very Excentrick Orbits, and make their Returns after long Periods of Time: For so their Number will be determinate, and, perhaps, not so very great. Besides, the Space between the Sun and the fix'd Stars is so immense, that there is Room enough for a Comet to revolve, tho' the Period of its Revolution be vastly long.

Now,

Now, the *Latus Rectum* of an *Ellipsis*, is to the *Latus Rectum* of a *Parabola*, which has the same Distance in its *Perihelium*; as the Distance in the *Aphelium* in the *Ellipsis*, is to the whole *Axis* of the *Ellipsis*. And the Velocities are in a Subduplicate *Ratio* of the same: Wherefore in very Excentrick Orbits this *Ratio* comes very near to a *Ratio* of Equality; and the very small Difference which happens on Account of the greater Velocity in the *Parabola*, is easily compensated in determining the Situation of the Orbit. The principal Use therefore of this Table of the Elements of their Motions, and that which induced me to construct it, is, That whenever a new Comet shall appear, we may be able to know, by comparing together the Elements, whether it be any of those which has appear'd before, and consequently to determine its Period, and the *Axis* of its Orbit, and to foretell its Return. And, indeed, there are many Things which make me believe that the Comet which *Apian* observ'd in the Year 1531. was the same with that which *Kepler* and *Longomontanus* took Notice of and describ'd in the Year 1607. and which I my self have seen return, and observ'd in the Year 1682. All the Elements agree, and nothing seems to contradict this my Opinion, besides the Inequality of the Periodick Revolutions: Which Inequality is not so great neither, as that it may not be owing to Physical Causes. For the Motion of *Saturn* is so disturbed by the rest of the Planets, especially *Jupiter*, that the Periodick Time of that Planet is uncertain for some whole Days together. How much more therefore will a Comet be subject to such like Errors, which rises
al-

almost Four times higher than *Saturn*, and whose Velocity, tho' encreased but a very little, would be sufficient to change its Orbit, from an Elliptical to a Parabolical one. This, moreover, confirms me in my Opinion of its being the same; that in the Year 1456. in the Summer time, a Comet was seen passing Retrograde between the Earth and the Sun, much after the same Manner: Which, tho' no Body made Observations upon it, yet from its Period, and the Manner of its Transit, I cannot think different from those I have just now mention'd. Hence I dare venture to foretell, That it will return again in the Year 1758. And, if it should then return, we shall have no Reason to doubt but the rest must return too: Therefore Astronomers have a large Field to exercise themselves in for many Ages, before they will be able to know the Number of these many and great Bodies revolving about the common Center of the Sun; and reduce their Motions to certain Rules. I thought, indeed, that the Comet which appear'd in the Year 1532. might be the same with that observ'd by *Hevelius* in the Year 1661. But *Apian's* Observations, which are the only ones we have concerning the first of these Comets, are too rude and unskilful, for any thing of Certainty to be drawn from them, in so nice a Matter. I design to treat of all these Things in a larger Volume, and contribute my utmost for the Promotion of this Part of Astronomy, if it shall please God to continue my Life and Health.

In the mean time, those that desire to know how to construct Geometrically the Orb of a Comet, by Three accurate Observations given, may

may find it at the End of the Third Book of Sir *Isaac Newton's* Principles of Natural Philosophy, entituled *De Systemate Mundi*, in the Words of its renowned Inventor. Which have since been more fully explained by my very worthy Collegue Dr. *Gregory*, in his Learned Work of *Astronomia Physica & Geometrica*.

One Thing more perhaps it may not be improper or unpleasant to advertise the Astronomical Reader; That some of these Comets have their Nodes so very near the Annual Orb of the Earth, that if it shall so happen, that the Earth be found in the Parts of her Orb next the Node of such a Comet, whilst the Comet passes by; as the apparent Motion of the Comet will be incredibly swift, so its *Parallax* will become very sensible; and the Proportion thereof to that of the Sun will be given. Wherefore such Transits of Comets do afford us the very best Means, though they seldom happen, to determine the Distance of the Sun and Earth: Which hitherto has only been attempted by *Mars* in his Opposition to the Sun; or else *Venus* in *Perigæo*; whose *Parallaxes* though triple to that of the Sun, are scarce any ways to be perceived by our Instruments; whence we are still in great Uncertainty in that Affair. This use of Comets was the ingenious Thought of that excellent Geometrician Mr. *Nicolas Facio*. Now the Comet of 1472, had a *Parallax* above Twenty times greater than the Sun's. And if the Comet of 1618, had come down, about the Middle of *March*, to his descending Node: Or if that of 1684, had arrived a little sooner at its ascending Node; they would have been yet much nearer the Earth,

Earth, and consequently have had more notable *Parallaxes*. But hitherto none has threaten'd the Earth with a nearer Appulse, than that of 1680. For by Calculation I find, that *Novemb.* 11^o, 1^h, 6', *P. M.* that Comet was not above the Semi-diameter of the the Sun to the Northwards of the Way of the Earth. At which Time, had the Earth been there, the Comet would have had a *Parallax* equal to that of the Moon, as I take it. This is spoken to Astronomers: But what might be the Consequences of so near an Appulse; or of a Contact; or, lastly, of a Shock of the Cœlestial Bodies, (which is by no means impossible to come to pass) I leave to be discuss'd by the Studios of Physical Matters.

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COMPENDIOUS VIEW

OF THE

ASTRONOMY of COMETS.

CONTAINING

Likewise an Accurate Calculation, in the Curve of an Ellipsis, of that whose Appearance is shortly expected.

WRITTEN in LATIN

By EDMUND HALLEY,

Late ROYAL ASTRONOMER.

And inserted in the Quarto Edition of his ASTRONOMICAL TABLES, published by W. INNYS, 1749; which, as the Patent recites, were more than 30 Years in Printing.

Translated by G. T. GENT.

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T O T H E

R E A D E R.

THE following Treatise having been translated some time since, for the Information of a few Friends, was not intended to be made Public, but many superficial pamphlets on the same Subject having lately made their appearance, which can give very little Information to their readers, and as many would be glad to know what Dr. *Halley* has really said himself on the Subject, were not the book in which it is contained of a large price, and the Language in which it is wrote, not generally understood. These considerations induced the Translator to this publication, that every one might, at a small price, and with little trouble in reading, have an insight into a Subject, in itself extreamly curious, abstracted from

any humdrum Reflections on the general Conflagration, or any vague Suppositions of the expected Comet's meeting the Earth on the 12th of *May*; which was never surmised by Dr. *Halley*, and inserted by Mr. *Martin* in his *Cometarium*, for no other purpose that I can conceive than to create a larger demand, many people searching eagerly after any thing strange or uncommon.

A Com-

EDMUND HALLEY was born in *London* Nov. 8, 1656, and brought up at *St. Paul's* School, under *Dr. Thomas Gale*. As the Stars at the South Pole are deficient in *Ptolomy* and *Tycho's* Catalogues, the Ancients seldom sailing beyond the Equator, and *Tycho* living too far North to observe them, *Mr. Williamfon*, Secretary of State, and *Sir Jonas Moor*, grand Master of the Artillery, applied to *King Charles II.* to send him to *St. Helena*, to supply their Defects: Being furnished with every Thing necessary, he set out in *November*, 1676, and arrived at *St. Helena* in three Months, where he performed his Project, and returned to *London* about the Autumn 1678; in 1679 he published his Catalogue of Southern Stars; among other Novelties it contained the Royal Oak, in which *King Charles II.* hid himself after the Defeat at *Worcester*, with this Inscription, *Robur Carolinum, in p rpetuam, sub illius latebris servati Caroli Secundi Magnæ Britannicæ Regis memoriam, in Cælum meritò translatum*: That is, *Charles's* Oak deservedly translated into Heaven, for sheltring under its Branches *Charles II.* King of *Great Britain*; from which it has been inferred, that Astronomers as well as Poets can find opportunities of thanking their Benefactors; he died *Jan. 25*, 1742.

The

A Compendious VIEW of the ASTRONOMY of COMETS.

THE antient *Egyptians* and *Chaldeans*, on the Testimony of *Dioderus Siculus* *, had learned, by a long Series of Observations, to foretel the appearing of Comets ; but as they are mentioned foreseeing Tempests and Earthquakes by the same Skill, it is beyond doubt, that their knowledge in these things might be more properly attributed to Astrology and Fortune-telling, than to any Astronomical Theory of their Motions ; and in truth the *Greeks*, who subdued both † these Nations, scarce found any other literature among them, insomuch that the Astronomy which the Moderns have so much improv'd, may be said to have been invented by the *Greeks* themselves, especially the great *Hipparchus* ‡.

Yet

* *Diodorus* wrote in *Greek* 40 Books, containing the affairs of the *Egyptians*, *Affyrians*, *Medes*, *Persians*, *Greeks*, *Romans*, *Carthaginians* and others, 15 of which have only come to our Hands ; he was born at *Agyrium* in *Sicily*, and lived in the time of *Julius* and *Augustus Cæsar*, 60 Years before *Christ*.

† *Alexander* the Great subdued all *Asia*, having defeated *Darius Codomannus*, about 325 Years before *Christ*, and about 60 Years before the first War between the *Romans* and *Carthaginians*.

‡ *Hipparchus*, a *Rhodian*, was the first among the *Greeks* who made a Catalogue of the Stars ; he lived about 120 Years before *Christ*, and his Observations are preserved by *Ptolomy*, in his

Yet the Opinion of *Aristotle* *, who would not allow Comets to be any thing but aerial Vapors, extending not so high as the Moon, prevailed so much among these very People, that this part of Astronomy, the most abstruse of any, remained entirely neglected; for no one thought it worth while to observe and commit to writing, the vague and uncertain Tracts of Vapors floating in the Air: And this has been the Reason that nothing certain has been transmitted to us concerning the Motion of Comets.

But *Seneca* † the Philosopher having considered the Phænomena of two remarkable Comets of his own Time, makes no scruple to rank them among heavenly Bodies, affirming they are Planets which will endure as long as the Universe; tho' he ac-

his *Almagest*, Book 7. This *Ptolomy's* Name was *Claudius*, born at *Pelusium* in *Egypt*, and flourished in the Reign of *Marcus Antoninus*, 140 Years after *Christ*, falsely taken by some for one of the Kings of *Egypt*; his Work was originally entituled *Συντάξις Μεγίστη*, that is, Greatest Collection, it being a Collection of Problems in Geometry, Geography, &c. the *Arabs* translated it about the Time of *Charlemagne*, Anno 800, and adding the Particle *al* to the Word *Μεγίστη*, called it in their own Language *Almagisti*, since which it has bore that Name.

* *Aristotle*, Preceptor to *Alexander* the Great, born at *Stagyræ*, a Town in *Macedonia*, 384 Years before *Christ*; his Works are extant both in *Greek*, and translated into *Latin*; he is reported to have said on his Death-bed, *Fœdè hunc mundum entravi, anxius vixi, perturbatus egredior causa causarum miserere mei*: That is, I was conceived in Uncleanneſs, have lived in Anxiety, and die in greater: Supreme Cause of all Things have Mercy on me.

† *Lucius Annæus Seneca*, called the Philosopher, to distinguish him from his Father the Rhetorician, born at *Corduba* in *Spain*, a little before the End of *Augustus's* Death; he was Preceptor to *Nero*, who, hearing that he was privy to a Conspiracy against him, ordered him to put himself to death, which he did by letting himself Blood in the Year of *Christ* 65.

know-

knowledges their Motions are regulated by Laws then unknown; and prophecies far from falsely, that the diligence and experience of some future Age would discover these Mysteries; and wonder that the Antients were ignorant of them: After that some Interpreter of Nature should demonstrate in what Regions of the Firmament Comets move, shewing both their Magnitudes and Qualities. Yet the greatest part of Astronomers have thought differently from *Seneca*; and he himself has not transmitted to us the Phænomena of the Motions on which his Opinion is grounded, nor the Time when he observ'd them, all which would have been of Use to the Moderns to determine this Controversy.

And after searching into many Histories of Comets, I find none than can be of any Use in this affair before the year of Christ 1337, when *Nicephoras Gregoras*, an Historian and Astronomer at *Constantinople*, describes to us accurately enough the Tract of a Comet among the fixt Stars, but he is very remiss as to the time of its appearance, on which account it merits a place in the Catalogue we shall give hereafter, no otherwise than that it is very probable it appeared about 400 Years ago.

After this, in the year 1742, *Regiomontanus* * observed a Comet, the swiftest and nearest the Earth of any; which tho' large in bulk, and having a terrible Tail, in one day passed thro' 40 degrees of a great Circle of the Heavens; and this is the first Comet concerning which proper Observations

* *Regiomontanus*, a German Astronomer; he abridged *Ptolomy's Almagestum*, he found many material Errors in the Translation of it, by *George of Trebizond*, and being made Archbishop of *Ratisbon*, and coming to *Rome* to reform the Calendar, he was killed by *George of Trebizonde's* Son, Anno 1476, others say he died of the Plague, aged 40.

have been transmitted us. However, all persons who have considered Comets before the time of *Tycho Brahe*, the great Restorer of Astronomy, imagining they were nearer the Earth than the Moon, little regarded them, esteeming them as Vapors.

But in 1577, *Tycho* * applying assiduously to the study of the Stars, and having collected large Instruments for measuring arcs of the Heavens with greater accuracy than the ancients could pretend to, there appeared a Comet conspicuous enough, which *Tycho* observed strictly, and found by many and just Experiments, that it had no sensible diurnal Parallax †, and consequently was so
B
far

* *Tycho Brahe*, born at *Knudstorp* in *Denmark*, December 1546, died Nov. 1601, at *Prague*, aged 54 Years, 9 Months, 19 Days. He was a Knight, and made Observations on the Stars a long time at *Uraniberg*, in the Isle of *Huen*, in the Sound, having fabricated curious instruments for that purpose at the expence of *Christian III.* King of *Denmark*. When he left *Denmark* he was entertained at the Court of the Emperor *Rodolph*: He had great intimacy with *William Prince of Hesse*: His works compleat were publish'd at *Frankfort*, 1648.

† What is meant by Parallax is, that supposing the Comet was observed from *Uraniberg*, and its distance from some fix'd Star noted: Again, suppose the same Comet was observed from *Prague*, and its distance from the same fix'd Star noted likewise; then if these two distances from the fix'd Star were the same in appearance, then would the Comet be said to have no sensible Parallax, which Astronomers conclude to be a Demonstration drawn from the Laws of Optics, that they are higher than the Moon; for that Planet, view'd from those two places before-mentioned, wou'd appear to have two different distances from the same fix'd Star.

Sir *Isaac Newton* takes another method of shewing that Comets are solid bodies, and not vapors; by instancing, that the Comet of 1680 came within a sixth part of the Sun's Diameter to his Surface, and therefore might, if a solid body, have contracted a heat 2000 times greater than red-hot iron; now had the Comet been vapor alone, the whole must have
been

far from being a Vapor, that it was much higher than the Moon; and in short, that no reason could be given that it might not be a Planet, notwithstanding the contrary assertions of the Pretenders to Learning of those Times.

The sagacious *Kepler* * followed, and by the help of *Tycho*'s labours, found out the true and natural System of the World, and immensely increased the Science of Astronomy: Shewing, that all the Planets revolv'd in Planes passing thro' the Center of the Sun, describing elliptic Curves in such manner, that equal Areae of elliptical Segments (the Center of the Sun being plac'd in the Focus of the Ellipsis) are always described in equal times, in which the Areas are described. He also found, that the Cubes of the distances of Planets from the Sun were as the squares of their periodic times. Two Comets appeared to this skilful Artist one more remarkable than the other: And from the Observations *Kepler* made on these, and by many Discoveries of an annual Parallax; he concluded, that

been dispersed by so intense a heat. He concludes therefore, that Comets are solid bodies, and that their tails are vapors, emitted from them by the great heat of the Sun, as steam is from water when heated by a great fire, and all the appearances agree perfectly with this sentiment.

* *John Kepler*, born at *Wial*, in the country of *Wurtemberg*, in 1571. *Tycho Brahe* having settled in *Bohemia*, and obtained all manner of conveniences from the Emperor *Rodolph* for perfecting Astronomy, prevail'd on *Kepler* to leave the University of *Glatz* and to come to him, which he did with his family and library in 1600; but *Tycho* dying in 1601, *Kepler* enjoyed the title of Mathematician to the Emperor all his life, who ordered him to finish the Tables of *Tycho Brahe*, which were to be called *Rodolphine*, which he publish'd in 1627. He died at *Ratisbon*, where he was soliciting the arrears of his pension.

Comets

Comets were freely carry'd about between the Orbits of Planets, with a motion not very different from rectilinear, but which he could not then determine.

Hevelius *, also *Tycho*'s rival, following the tract of *Kepler*, embraced the hypothesis of a rectilinear motion; but notwithstanding he was an acute observer of many Comets, yet he complains that his calculation did not correspond entirely with nature, and suspected that Comets described a curve round the Sun.

At length the prodigious Comet of the year 1680 appeared in the heavens, seemingly descending perpendicularly towards the Sun, and afterwards ascending with the same velocity therefrom; and having been seen for four months together, and discovering a peculiar and remarkable curvature of its Orbit, was more proper than any to give light to the theory of its motion. And the Royal Observatories of *Paris* and *Greenwich* having been long since erected, and intrusted to the care of the most eminent Astronomers, it so fell out, that the apparent motion of this Comet was observed by *Cassini* † and *Flamsteed* §, with as much accuracy perhaps as mortals are capable of.

B 2

Not

* *Hevelius*, Burgo Master of *Dantzic*, he discovered a great many Stars, which he calls *Sobieski's Firmament*, in honor of *John III.* king of *Poland*: He died in 1688, aged 76.

† *Cassini John Dominic*, was born in the county of *Nice*, in 1625, and being taken notice of by *Colbert*, chief minister to *Lewis XIV.* became one of the greatest Astronomers of his time: He died in 1712.

§ *John Flamsteed*, born at *Derby*, *August 19*, 1646; he went to *Cambridge*, entered a student of *Jesus College* there, and became acquainted

Not long after which, *Newton* *, the chief of Geometers, having composed his Mathematical Principles of Natural Philosophy, he not only demonstrated, that the Discoveries of *Kepler* must necessarily have a place in the Planetary System, but that all the phænomena of Comets must necessarily follow from the same principles, which he hath sufficiently illustrated by an example from the aforesaid Comet of the Year 1680, and shewed the manner of constructing Geometrically, or with exactness, the Orbits of Comets: To the wonder of all men solving a most difficult problem, and worthy of so great an *Oedipus* †. He
proves

acquainted with Mr. *Newton*, Dr. *Barrow*, and Dr. *Wroe*: Sir *Jonas Moor* having strongly recommended him to king *Charles* the Second, and the Duke of *York*. March the 4th, 1674, he brought Mr. *Flamsteed* a warrant to be king's Astronomer, with the salary of 100*l.* per Annum, the Easter following he was ordained. In 1684 he was presented to the living of *Burston* in *Surry*, which he enjoyed till he died, Anno 1719, aged 83; his *Historia Cælestis Britannica* was published Anno 1725.

* *Newton*, Sir *Isaac*, was born at *Woolstrop*, in the county of *Lincoln*, on Christmas-day, Anno 1642: He was descended from the elder branch of Sir *John Newton*, Baronet. In 1696, Mr. *Montague*, then chancellor of the Exchequer, obtained of the king for him the office of warden of the Mint, and three years after he was appointed master of the Mint. In 1701 he was elected a second time member of parliament for the University of *Cambridge*. In 1703, he was elected President of the Royal Society, and continued in the chair 23 years, till his death. In 1705 he was knighted by queen *Anne*: He died March 20, 1726.

† *Oedipus*, according to the fabulous history, was the son of *Laius* and *Jocasta*, king and queen of *Thebes*; his father being informed by the oracle that his son would kill him, gave him to his shepherd to be slain, but he being moved with pity, only left him in a desert place, where he imagined he would die with hunger; but he was taken up by one *Phorbas*, belonging
ing

proves this Comet to have moved round the Sun in an Orbit apparently parabolical in such manner, that the *areae*, reckoning from the center of the Sun, are proportionable to the times.

Pursuing the steps of so great a man, I have endeavoured to accommodate an arithmetical calculation thereto, and not without success; for having collected from all parts the observations made on Comets, I obtained the following Table, the fruit of immense calculations, a small but acceptable present to Astronomers; for these numbers are sufficient to describe accurately every thing that has hitherto been discovered concerning Comets, by the help alone of a General Table that accompanies it; in constructing which I have spared no pains to render it perfect, and I dedicate it to Posterity, imagining it will last as long as the Science of Astronomy.

This Table, which was intended for no persons unskilled in the Mathematics, contains a List of

ing to *Polybius*, king of *Corinth*, and brought to that place, where the queen brought him up as her own son; but he afterwards finding that he was not her child, went to seek his father at *Phocis*, and there being a sedition in that city, he unwittingly slew his father; after which *Creon*, the succeeding king, proclaimed over all *Greece*, that any man who could expound the Sphynx's riddle, should marry his sister *Jocasta*; the riddle was, What animal is that which in the morning goes on four feet, at noon with two, and at night with three? *Oedipus* undertook it, and said it was a man, who in his infancy crawls on hands and feet or on all fours, in his middle age walks on two legs, and when he is old uses a staff, or goes on three; whereupon he obtained the prize, and had two children by his mother, *Eteocles* and *Polynices*, who slew one another, and she slew herself. Hence unfortunate people are said to be of the race of *Oedipus*, and the resolvers of difficult problems to be an *Oedipus* himself.

24 Comets, beginning from the year 1337, and ending in the year 1698.

Now three only of this number have reference to the Comet expected to appear about the end of the year 1758, or beginning of the next, and are as follows.

The Comet of the year		had its Orbit inclined			Its nearest distance to the Sun was		
		deg. min. sec.			deg. min. sec.		
of	1531	{	17	56	0	} Aquarius	1 39 0
	1607		17	2	0		2 16 0
	1608		17	56	0		2 52 45

Having finished the above Table, I suspected from the similar situation of the Planes and Perihelions, that these three Comets were one and the same; having made its third revolution in the curve of an Ellipsis *; but as I found rather too much difference

* If a strait line of what length you please be a little bent, it will thereby become what Geometricians call part of an Hyperbola; bend it a little more, and it will thereby become part of a Parabola; bend it a third time, and it will become part of an Ellipsis; bend it still more, and in this last degree of curvature it will be part of a Circle: Now these crooked lines, according as they are more or less bent, serve for solving different Problems, for what you may perform by the help of one could never have been resolved by the other: For instance, a man who understands the properties of a Circle would easily make a square floor, or any other surface double or treble, &c. any other you please. Yet without the knowledge of the properties of a Parabola, he would never be able to increase or diminish, in any proportion, a solid stone pediment called a cube or die.

As

ference in some other respects, and esteemed the Observations of *Apian* and *Kepler*, who made them too inaccurate for clearing up so subtil a point; I was content on first publishing this Compendium in the Year 1705, only to point out this as my opinion, supported by some degree of probability, and advised posterity to be strictly on the watch for its return, which I expected about the year 1758.

But he goes on and says, that since the first publishing the Compendium, he had found out a method of easily and accurately computing the motions of Comets in any Ellipsis whatever: And that in turning over the Catalogues of ancient Comets, he had found three more preceding the others in the same order and intervals; to wit, in 1305, about *Easter*; in 1380, the month uncertain; and another in 1456, in the month of *June*; and this made him resume his former opinion with more confidence than formerly, so that in the whole he had obtained a catalogue of six Comets, which appeared in the years 1305, 1380, 1456, 1531, 1607, 1682; and being thus prepared, instead of the parabolic Orbit which he had

As to what Carpenters, Masons, and other artificers perform without the knowledge of any properties of Lines at all, it is from the rules that thinking men have laid them down, and which they are content to use on their faith, without pretending or being capable to examine into the truth of the demonstration, for many people can dexterously put in practice the inventions of others, if you will take the pains to instruct them, tho' they fall short of a capacity to be inventors themselves.

Now the computation of a Comet's motion in an Ellipsis was heretofore very difficult, which made *Dr. Halley* compute them as moving in the curves of Parabola's, therefore it was not strictly accurate on that account.

had attributed in his former table to the Comet of 1682, he substituted new Tables of an Elliptic one, and then try'd if Mr. *Flamsteed's* Observations on this very Comet, and which were taken with a very large and accurate sextant, and duly cleared from refractions, would correspond with his Theory.

Now it is manifest by the Catalogue, that two periods of this Comet amount to 151 years nearly, and that they are alternately greater and less, the one of 56, and the other of 55 years; afterwards applying this and other data, as directed by 15 Prop. 1st book of *Newton's Principia*, by the help of his new Tables, he finds, that on the 30th of *August*, 1682,

The place of this Comet according to his Theory
was,

		deg.	min.	sec.
	Libra	15	35	58
and according to a real observation made by <i>Flamsteed</i> it was,	} Libra	15	34	42

And its North Latitude according to his Theory
was,

		deg.	min.	sec.
		17	24	42
and by a real observation made by <i>Flamsteed</i>	} 17	24	46	

Now the Difference between the computed and observed places, is but 1' 16", and that of their Latitudes only 45", which difference he thinks
deserves

deserves no regard, since they may as well be attributed to errors in the Observations, as well as to those of the Calculations: And Astronomers seldom make less in their Theories of the primary Planets, which they have cultivated for so many years.

And in the same manner he found his Theory agree with every one of *Flamsteed's* Observations, except such trifling differences, of which he gives a Table.

Having thus far established his Theory, he takes into consideration the course of the Comet in 1607, which preceded that of 1682, which *Kepler* and *Longomontanus* say they observed; but though they were great Astronomers, they have transmitted too remiss a description, and not sufficiently exact for the present enquiry: But such as they have given are,

The Comet preceding that of 1682; to wit, in 1607, was observed by *Kepler* at *Prague*, the 16th of *September* that year, old stile, at nine o'clock at night,

		deg.	min.
and he estimates its place,	<i>Leo</i>	18	30
and North Latitude		35	$\frac{1}{2}$

But as the places of the fix'd Stars are falsely described in *Tycho's* Tables by some mistake; when they are set to rights, its apparent place at *London*, 51 minutes past 1 in the morning was,

		deg.	min.	sec.
	<i>Leo</i>	21	49	00
and at the same time and place,				
according to <i>Halley's</i> Com-	} <i>Leo</i>	21	55	56
putation its place was,				
	C			the

the difference of which places are but 6 minutes, 56 seconds.

And its North Latitude, as observed

	deg.	min.	sec.
by <i>Kepler</i> was,	36	12	0
and by <i>Halley's</i> Computation	36	20	4

the difference of which Latitudes are 8 minutes 4 seconds.

And out of 12 different observations made by *Kepler* and others, when the undoubted errors in their observations are set to rights, there is very little difference between them and *Halley's* Computations, and that difference which there is, the candid reader will easily observe is to be attributed for the most part to the observations, which are not altogether congruous amongst themselves.

As to the period of one of the Comet's revolutions exceeding the other by more than a year, he reminds the reader, that it is no more than what he has demonstrated in his Tables of the Planet *Saturn*, where one of that Planet's revolutions is 13 days longer than the other, and is the consequence of one of the Laws of Gravity explained by *Newton*; and this irregularity he says, must be abundantly greater in a Comet which emerges 4 times higher than *Saturn*; and it is probable he says, this irregularity which is not accurately known, may make the next expected return of this Comet something more than 76 years, and it may not be seen again till the end of the year 1758, or beginning of 1759; but this he leaves to the discussion of posterity.

That the Comet observed by *Appian* in 1531, which is next preceding that of 1607, was the same

same as the other two, is pretty evident from the situation of the Nodes, its Perihelion and Inclination which are not very different from the other two; but the imperfect observations made by him with a small azimuth instrument, whose only use was to shew the ascent of the Comet's tail in the parts opposite the Sun, render all attempts to reduce those observations to accuracy ineffectual. However, that he would omit nothing, he with great trouble procured *Appian's* Book, intituled, *Astronomicon Cæsareum*, dedicated to the Emperor *Charles V.*

But as the Longitude of the fix'd Stars were very erroneously assign'd at that Time to what they are at present, if the true ones are substituted, as likewise allowance made for the refractions, the places of that Comet were thus,

True place of Comet.

		deg.	min.	sec.
<i>August</i> 13, 1531,	<i>Leo</i>	20	16	0
23	<i>Libra</i>	3	49	0

But according to *Appian's* observations.

		deg.	min.	sec.
<i>August</i> 13, 1531,	<i>Leo</i>	19	15	0
23	<i>Libra</i>	1	23	0

Now tho' *Appian's* places of the Comet differ from the true ones, on account of his using wrong Latitudes and Longitudes of the fixt Stars, and bad instruments; yet the differences are not equal in all, but greater in some, and less in others, which shews they were not all equally accurate, for on the 13th of *August* he differs but 1 degree, 1 minute from the truth, but on the 23d of *August* he differs from the true place 2 degrees 26 minutes,

so that they differ among themselves more than from the true observations, which makes it impossible to reconcile such inconsistencies; however, 'tis sufficient to shew that this Comet kept a tract very similar to that of 1682, and if you make a little addition to the latitude, almost the very same.

As this Theory agrees with the real observations of three different Comets, made in 1531, 1607, and 1687, it would be next to a miracle if three different Comets should three times keep the same tract, and more than a miracle if it were not the third revolution of the same Comet, in an elliptic curve: If therefore he says it appears again about the year 1758, impartial posterity must needs allow this to be the discovery of an *Englishman*.

And this he says is as it were the Mercury of Comets revolving round the Sun in the smallest Orbit, whilst others appear not again under the space of a hundred, and some of many hundred years; at which time, arriving in the neighbourhood of the Sun, they shine with a greater lustre, and send forth conspicuous tails, which are nothing but subtle vapors exhaled from the body of the Comet by the intenseness of the Sun's heat, as steam from water set over the fire; but concerning this he refers to *Newton* according to his custom, arguing very forcibly at the end of the third book of his *Principia*, who therein, among other things, enters into the following speculation; to wit, that the earth (by furnishing such a quantity of moisture for the growth of vegetables, which when they wither become dry substances) would in a sufficient length of time be exhausted, and left a hard and dry body, unless supply'd by some means or other: Now the tails of Comets, like
other

other vapors, dilate themselves as they ascend, and consequently are scattered through all the planetary regions, and from thence are gathered up by the Planets as they pass thro' their Orbits, for they have a power to attract all bodies to them: Now these vapours, by entering into the atmosphere of the earth, may well be supposed to contribute to the renovation of all things, and in particular to supply the diminution caused in the humid parts of the earth by putrefaction and vegetation. So far are they from portending any mischief to us, which the natural fears of men are so apt to suggest, from the appearance of any thing strange or uncommon.

And that the tails of Comets have some such important use is very reasonable, if we consider, that these bodies seem to be framed of a texture which purposely disposes them to fume in that sort, and that they do not merely emit those fumes or tails by their near approach to the Sun alone without any other consideration; for the earth is more than half the year at a less distance from the Sun than either of the two Comets were, which appeared in the years 1664 and 1665, when they were nearest thereto; and the Comet of 1682 never approached the Sun above half so near as *Mercury* did, and but very little nearer than *Venus*; yet all those Comets emitted tails, whereas both the Earth, *Mercury* and *Venus* were free from any such appearances.

The only objection that can be made against this opinion, is the difficulty of explaining how a sufficient quantity of vapor can be raised from the body of a Comet, to fill those vast spaces, through which their tails are sometimes extended.

Which

Which Sir *Isaac Newton* removes by the following computation; and he finds, that a Globe of such air as we breath in, which shall be only one inch in diameter, if it were carried up to the height but of one Semidiameter of the earth, would thereby become so rarify'd, that it would fill all the planetary regions, even to the sphere of *Saturn*, and far beyond: now as the tails of Comets are much higher, they may easily be conceived to fill all that space they are seen to take up.

The only scruple left is, how these tails can reflect light enough as to appear bright and shining, if they are composed of so thin a vapor as this computation implies; for the removal of which, Sir *Isaac Newton* observes, that the most refulgent of these tails, hardly appears brighter than a beam of the Sun's light transmitted into a dark room thro' a hole of a single inch diameter, and that the smallest fix'd Stars are visible thro' them without any sensible diminution of their lustre.

All these considerations put it beyond doubt what is the true nature of the tails of Comets; and as to what has been reported of the strange shapes in which those tails have appeared, as no such thing has been recorded by Astronomers, who, on the contrary, ascribe the same likeness to the tails of all Comets; he refers all those to accidental refractions, by intervening clouds, or to parts of the milky way contiguous to the Comets *.

And that the tails of Comets are vapors he further confirms from the following considerations: First, the tails of Comets are but small, while they are at a great distance from the Sun, but enlarge

* These arguments are laid down Phil. Princip. of Natural Philosophy, Page 509, to 517.

in proportion as they approach him, which shews that the tail depends upon the degree of heat which the Comet receives from the Sun. Secondly, the tails of Comets are always opposite the Sun, in the same manner as steam or smoke ascends from the fire that produced it. Thirdly, the tails of Comets perfectly resemble the smoke or vapor of a burning coal, for if the coal remains fixed, the smoke ascends perpendicularly, but if the coal be in motion it ascends obliquely, and the different appearances of the heads of Comets, greatly confirm this opinion of their tails ; for smoke raised by a strong heat is blacker and grosser than when raised by a less ; and accordingly the heads of Comets, having been more heated by the Sun, are less shining than when they were less heated, just as if they were then obscured by such gross smoke.

Fourthly, these tails or vapors are likewise found to participate of another property of ascending vapor, which is, that when it ascends with the greatest velocity, it is least incurvated.

And lastly, from the very near approach to the Sun of the Comet of 1680, Sir *Isaac Newton* draws another Speculation ; to wit, that some people have heretofore suggested, tho' it be very difficult to prove, that the Sun, by a constant emission of light and heat, does really diminish ; now should that be the case, yet might a Comet approach so near its surface as to be attracted thereto, and thereby supply any decrease it may have hitherto undergone.

The reader will easily perceive, that entering farther into this subject would have engaged me in such sort of Calculations, as depend on principles the generality of people are unacquainted with,
and

and which has been avoided as much as possible, thereby to render it intelligible to a greater number; I shall therefore take leave by observing, that Sir *Isaac Newton* concludes his *Mathematical Principles of Natural Philosophy*, by giving his thoughts concerning the Deity, wherein he remarks, that the Similitude and Symmetry found in all the parts of the universe, make it undoubted that the whole is governed by one Supream Being, to whom is owing the Original of the frame of Nature, which evidently is the effect of choice and design, and stating briefly the Metaphysical Notions of God, he concludes, that the Deity must necessarily be both immense and Eternal.

F I N I S.